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HEADQUARTERS QUARTERMASTER RESEARCH & ENGINEERING COMMAND, US ARMY  
Quartermaster Research & Engineering Center  
Natick, Massachusetts

CLOTHING & ORGANIC MATERIALS DIVISION

Clothing Branch Series  
Report No. 35

LOW TEMPERATURE STUDIES ON COMPATIBILITY  
OF PROTECTIVE HEADGEAR ITEMS

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by

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Project Reference:  
7X79-10-003

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November 1962

20010719 049

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## FOREWORD

A recommendation was made at the Arctic Test Planning Conference held in April 1962 that a joint QMC-CmLC working party be formed. The purpose of the working party was to study the compatibility problems of all standard head-gear items that are required to be worn in cold-dry environments. In addition, the group was charged with making recommendations for the alterations of any incompatibilities noted. On 24 May 1962, the working party met at Natick, Mass., and studied various combinations of head-gear items and planned low temperature (cold room) tests which were completed on 22 August 1962. This report is being reproduced as a Clothing and Equipment Development Branch Report as a means of obtaining copies which can be used as a guide during the 1962-1963 winter test program.

## SUMMARY

Cold room studies were conducted on all possible combinations of standard environmental, ballistic and CBR protective items to determine compatibility of the various ensembles. The controlling factors for selecting combinations for further study were: environmental protection, freedom of head movement, functionability, and ease of donning. Of all combinations studied, only three (3) combinations appear to have sufficient merit to be considered further. These combinations are as follows:

Combination I - Consisting of the pile cap (without bill), M1 steel helmet and liner, M17 field protective mask, E33 protective hood, and the fur ruff hood.

Combination II - Consisting of the pile cap, (with or without bill), M17 mask (without E33 hood), fur ruff hood, no steel helmet.

Combination III - Same as II above, except that the E33 hood is worn with the M17 mask and the steel helmet (without helmet liner) is worn over the fur ruff hood and is stabilized by pulling the parka hood over the helmet.

## I. INTRODUCTION

### Background Information

Because of difficulties experienced during ATB 1961-1962 winter test of the E33 protective hood, worn with the M17 field protective mask and standard cold weather garments, a recommendation was made at the arctic test planning meeting, on February 1962, to form a joint QMC-GmLC working party to study the compatibility problem. The group was also charged with making recommendations that would lead to improved compatibility.

On 24 May 1962, the working party met at Natick, Mass., and studied the following items:

- a. Helmet, Steel, M1 and liner with old and new type suspension system
- b. Mask, M17 and protective hood, E33R2
- c. Cap, Field, Pile, M51
- d. Hood with fur ruff.

It was noted that all the above standard items were designed to fit properly over the bare human head (the fur ruff hood will go over the pile cap). In effect, the items can be grouped into three different and independent protective systems, as follows:

- a. Ballistic: the steel helmet and liner
- b. CB: the protective mask and hood
- c. Environmental: the pile cap and fur ruff hood.

The working party noted that it is almost a complete bonus that any degree of integration of the above three systems is possible. The decision was made to evaluate, in the laboratory, every possible combination of the headgear items to note estimated degree of compatibility and to suggest simple means whereby the compatibility could be improved. Cold chamber tests were planned and scheduled to take place at CRDL in the latter part of August 1962.

## II. DESCRIPTION OF MATERIALS

### (1) CBR Protective Items:

a. Mask, Field Protective, M-17. This item consists of a head-harness, two rigid plastic eyelenses, voice-mitter-outlet valve assembly, face-blank, two filter elements which are contained in pouches molded as an integral part of the faceblank, two air inlet valve assemblies and a nose cup.

b. Ice Particle Prefilter. This accessory item is designed to prevent clogging of the mask inlet valve assemblies by ice particles or fine snow. It is butterfly shaped and is made from single face-nylon cloth. The prefilter wraps around the lower portion of the mask filter element pouches and extends upward and over the air inlet valve assemblies.

c. The E33R2 protective hood. This item is provided for protection against vapors, aerosols, and droplets. It is made of butyl-rubber-coated nylon cloth and has five openings to accommodate the eye-pieces, inlet valve assemblies and voice-mitter-outlet valve assembly of the mask. Underarm straps secure the bottom or apron of the hood on the wearer's shoulders. A neck cord enables the hood to be pulled close around the wearer's neck.

### (2) Environmental Headgear Items:

a. Cap, Field, Pile, M-1951. This standard item has long ear-flaps and a visor. During the experiments, the visors of some caps were removed by cutting the stitches which secure the visor to the cap.

b. Hood, Winter, Fur Ruff.

### (3) Ballistic:

a. Helmet, Steel, M-1 with liner, with both old and new suspension systems. A new helmet liner suspension system was adopted at the QMTC meeting 8-61, 25 October 1961. This suspension system changes the position of the helmet so it tilts slightly forward, and employs a nape strap to insure a more stable fit.



### III. COLD CHAMBER STUDIES

#### (1) Headgear Combinations Studied:

- a. Steel helmet over pile cap.
- b. Steel helmet and the M-17 field protective mask (with and without the E33R2 protective hood).
- c. M-17 mask and pile cap.
- d. M-17 mask and fur ruff hood (with and without pile cap).
- e. Steel helmet and hood, fur ruff (with pile cap).
- f. Steel helmet, M-17 mask and hood, fur ruff (with and without pile cap).

#### (2) Conditions:

- a. Environmental: 40°F and 10 MPH wind.
- b. Subjects were dressed in complete arctic clothing assembly.
- c. The M-17 field protective mask was fitted with lens outserts and an ice prefilter.
- d. Subjects were exposed for 30-60 minutes. They exercised for one third of the exposure time on the treadmill at the rate of four (4) miles per hour at an incline of 2° facing the wind.
- e. Leakage tests of the protective mask seal were conducted after each cold room exposure.
- f. Subjects completed a questionnaire after each trial.
- g. On the last day of the evaluation, the subjects donned and adjusted their headgear systems inside the cold room.

#### (3) Results:

##### a. Steel Helmet over Pile Cap:

Compatibility Rating: Fair. In order to wear this combination, the helmet liner suspension must be loosened to accommodate the increased dimension of a head covered by the pile cap. When the helmet is worn over the pile cap with the visor turned down, the visor will be pushed over the eyes. The cap's visor can be turned up; however, this further increases the bulk of the head. Maximum adjustment of the helmet liner suspension system is barely or not sufficient to accommodate the larger size heads (size 7½ and above) when wearing the cap. This is true for both the old and new helmet suspension systems. The stability of the helmet, worn over the pile cap, is definitely reduced, although much less with the new suspension system. In addition, the protection to the wearer's forehead and temple is reduced considerably.

##### b. Steel Helmet and M-17 Mask:

Compatibility Rating: Old suspension system: Poor. New suspension system: Fair. When the steel helmet is worn over the M-17 field protective mask, it is no longer possible to use the chin straps.

With the old suspension system, it is nearly impossible to keep the helmet secured on the head, especially when the soldier "hits the dirt" or rolls on the ground. While using the new suspension system, it is possible to keep the helmet secure on the head. Care should be taken that the helmet does not ride or bounce on the protective mask eyelenses. This frequently results in a break of the seal between the mask and the face.

c. M-17 Field Protective Mask, E33R2 Hood, and Pile Cap:

Compatibility Rating: Low. In this combination, the mask is donned first. The pile cap can be worn under or over the E33 hood. The cap must be somewhat oversized to begin with since it must accommodate an increased head size. The major deficiency of this combination is that the ear flaps of the pile cap are too short to reach under the chin or jaw because of the bulk of the mask. As a result, the neck area remains completely unprotected from the cold, except for the material of the E33 hood.

d. M-17 Field Protective Mask and Fur Ruff Hood:

Compatibility Rating: Fair. This combination produces one major problem. Due to the bulk of the protective mask, it is not possible to close the hood in the neck area, and to close the zipper of the field jacket all the way to the top. Thus, the neck area of the wearer is seriously exposed. However, if the E33 hood is used with the M-17 field protective mask, the skirt of the hood aids in preventing exposure of the neck area. If the M-17 mask or the E33 hood were equipped with a winterizing attachment designed to protect the neck area of the wearer, this particular combination could be considered acceptable. The same result could be obtained if the neck area were protected by a scarf or similar item. A neck protective skirt, as a winterizing attachment to the mask ice particle prefilter, appears to be the simplest solution.

e. Steel Helmet, Pile Cap, and Fur Ruff Hood:

Compatibility Rating: Incompatible. The steel helmet cannot be worn under the fur ruff hood; there is simply not enough room for the helmet. Neither can the steel helmet with liner be worn over the fur ruff hood; the helmet would be riding too high, and there appears to be no way of stabilizing the helmet. An attempt was made to wear the helmet without the liner over the fur ruff hood. The hood attached to the parka was pulled over the helmet as a means of keeping the helmet on the head. This approach appears to merit some consideration as an emergency way of allowing the helmet to be worn under conditions where it could otherwise not be worn at all.

f. Steel Helmet, M-17 Mask, Fur Ruff Hood:

Compatibility Rating: Incompatible. As pointed out in the discussion of combinations d. and e., this combination cannot be worn

without seriously compromising environmental, ballistic and CBR protection. In addition, it will greatly hamper the ability of the wearer to function as an efficient unit.

#### IV. MODIFIED WAYS OF WEARING THE ITEMS

1

- a. Pile Cap (without the bill).
- b. Steel helmet and liner.
- c. M-17 field protective mask and E33R2 protective hood.
- d. Fur ruff hood worn down.

In this combination, the M-17 mask and E33 protective hood are donned first. The pile cap is worn next. The steel helmet is then fitted over the pile cap. The fur ruff hood is arranged around the wearer's neck to protect the neck area. Donning requires near bare hand dexterity and an average of  $2\frac{1}{4}$  minutes was required to don the complete assembly. Subjects reported that this combination provided adequate comfort during 60 minute exposures under conditions of the test. Subjects also reported that the straps on the prefilter were difficult to find (corrected by a new design which does not require straps) and that the E33R2 hood was the only means of keeping the neck area warm.

2

- a. Pile Cap (with or without bill).
- b. M-17 field protective - without E33R2 hood.
- c. Fur ruff hood.
- d. No helmet.

With this type ensemble, without E33R2 protective hood, the fur ruff hood must be used to provide environmental protection, supplemented by a neck bib or scarf to compensate for the inadequate protected neck area. During this test, the neck protector was an integral part of the mask ice particle prefilter. The subjects rated this combination as the most comfortable assembly, being the easiest to don under cold conditions. The average donning time was 1 minute, 46 seconds.

3

Same as 2 above, except the E33R2 hood was worn with the M-17 mask and the steel helmet (without liner) was worn over the fur ruff hood and kept in place by pulling the parka hood over the helmet.

This combination has the advantages that all components--except the helmet liner--are actually worn. However, the combination performed less satisfactory than combinations 1 and 2 above. The helmet, covered by the parka hood, tends to exert a downward pull on the wearer's head. Subjects who wore this combination reported peripheral leaks in the mask and stated that it was difficult to move their heads.

## V. CONCLUSIONS

It is concluded that:

a. Any selection of a protective headgear system should be predicated not only on the functioning of each individual item, but also on the manner each item functions in the total system.

b. Proper functioning will not be obtained with any headgear system, unless the donning manipulations and all adjusting features are simple and straight forward.

c. There is no satisfactory method of wearing the steel helmet with the standard environmental headgear system.

d. Wearing the steel helmet, pile cap, and fur ruff hood over the M-17 field protective mask causes malfunctioning of the mask.

e. If the soldier wears only the environmental headgear in cold-dry environments, it will be feasible to convert to a headgear combination that will include the M-17 field protective mask with or without the E33R2 hood (modified combination 2).

f. If all protections are required, the soldier must select modified combination 1.

g. Although the three modified combinations listed in Section III can be worn, it can be expected that a price will be paid in terms of decreased protection.

## VI. RECOMMENDATIONS

It is recommended that:

a. Protective hoods to be worn with the M-17 field protective mask in cold-dry environments be made as a special winterized hood from low temperature flexible materials having a neck insulating feature and not more than one adjustment to secure the hood.

b. The US Army Test and Evaluation Command conduct an evaluation of the three (3) preferred combinations outlined in Section III of this report to determine which of these systems would best meet the Army's needs, taking into consideration mask leakage, loss of environmental protection, reduced ballistic protection, and reduced freedom of head movement.

c. It is further recommended that several of the components of the new integrated combat clothing systems be considered as solutions for several of the compatibility problems noted. For example, the new cap, insulated, integrated, has no bill and is extremely simple to adjust. The new hood, integrated, fur ruff, actually has the capability of accommodating the M-1 steel helmet and liner and has superior adjustment features.

#### ACKNOWLEDGEMENTS

The authors wish to express their appreciation to Dr. J. Kobrick, Mr. R. White, and Miss Jean Crosson of Natick Laboratories for their contributions during the first meeting of the group, and also Mr. John Deppisch of CRDL for his most valuable assistance during the low temperature studies.